silica/zirconia or, preferably, zirconia containing mixed oxides, dispersed palladium metal, or dispersed mixtures of platinum and palladium.

[0060] The reforming side of the separator plate is coated with one or more catalytic materials suitable for the reforming of fuels. Common reforming catalysts include mixed oxides such as $NiO\text{-}MgO\text{-}Al_2O_3$ with small additions of CaO and K_2O. It should be noted, however, that nickel-based catalysts facilitate the formation of undesired carbonaceous deposits. The heavier the fuel, the more serious is the problem of carbon deposition. Rhodium-based reforming catalysts have been proposed as an alternative to nickel-based catalysts because carbon forms on rhodium catalyst compositions at a reduced rate, as compared to Ni-based catalysts. Rhodium metal can be dispersed on alumina, zirconia, or zirconia modified with additives such as Ce and La to increase catalytic activity and stability, the latter referring to the ability to maintain catalytic activity for a longer period of time, thus leading to longer service life. Other platinum group metals, notably Pd and Ru, may be used as reforming catalysts.

K. Catalyst Preparation

[0061] After formation of alumina whiskers, the aluminum/steel alloy sheets, foils or platelets are treated with inert zirconium-containing compounds, preferably, a suspension or sol of zirconium oxide or hydrated zirconium oxide containing the selected catalyst metals (e.g., Pd, Ru, Rh). The zirconia-based sols typically contain mixed oxides of silicon or titanium and additives such as barium, cerium, lanthanum to enhance the catalytic activity and thermal stability of the material. The catalyst metals are fixed on the inert oxide powder prior to coating the steel sheet by impregnating the zirconium oxide powder with the metal salts followed by heat treatment in air. The catalyst metal/inert oxide mixture may then be milled to form a colloidal sol. The resulting sol is applied to the substrate by spraying, dipping, roller

coating, brushing, or the like, preferably by spraying. After application of the suspension, the sheets, platelets or foils may be dried and heat-treated in air to form a high surface area oxide layer firmly adhered on the metal surface.

[0062] An alternate process for applying the catalyst layer to the support structure is first to deposit a coat of the inert zirconia-based compounds, called a washcoat, followed by adding the catalytic metals to the inert oxide layer by applying a solution of a salt of the catalyst metal (as a precursor of the metal itself). In more detail, the washcoat layer is applied to the sheet support by brush or roller coating, by spraying, or by dipping the sheet into the sol material. After applying the washcoat to the sheet surface, the coated sheet is heat-treated in air to promote bonding of the washcoat to the alumina whiskers or crystals on the sheet surface. Next, metal salt precursors such as palladium nitrate or rhodium chloride are applied (by spraying, dipping brush, or roller) to the washcoat layer. The materials are then heat-treated in air to decompose the metal salts and secure the catalyst metals to the washcoat in an evenly dispersed coating, predominantly very fine crystallites.

L. Use of Reactor in Conjunction with a Fuel Cell

[0063] The plate reactor described herein can be used as part of a fuel processor to convert a hydrocarbon fuel to hydrogen for use in a fuel cell which catalytically converts H_2 and O_2 to water, generating electricity and heat in the process. In a typical fuel cell, H_2 is fed through a catalyst-containing anode, which converts it to H^+ and electrons. The electrons are diverted to an external circuit to provide electrical energy for an external device such as a motor, then are returned to the cathode side of the fuel cell. O_2 is fed through the catalyst-containing cathode, where it is catalytically combined with H^+ and electrons to form H_2O.

[0064] For example, methane or natural gas which consists mainly of methane can be combined with steam and fed to the reforming reaction channel of the

inventive device. Simultaneously, methane or natural gas can be combined with air or oxygen and fed to the combustion reaction channel of the inventive device. The exothermic combustion of methane will then supply heat to the endothermic steam reforming of the methane to form a hydrogen and carbon monoxide containing mixture. This mixture can be subsequently sent through other reaction steps such as water gas shift and carbon oxide preferential oxidation to produce a hydrogen containing mixture for use in a fuel cell to generate electrical power. The combined system would allow the rapid and cost effective generation of electrical power from a hydrocarbon fuel. The use of the inventive plate reactor would allow the system to be compact, light weight and cost effective.

M. Use of Plate Reactor in Conjunction with a Start-Up Heater

[0065] One advantage of the plate reactor system is that the thin separator with the catalyst coating has a small heat capacity and can be heated quickly. Specifically, it can be heated rapidly by preheating the gas flowing through the reaction channels. This provides a means for rapid start up. For example, a small heater can be provided upstream of the plate reformer to heat the gas mixture entering either the oxidation reaction channel or the reforming reaction channel, or both channels. This hot gas mixture may then enter the plate reactor and heat the thin separator. The hot catalyst-coated separator would then have sufficient catalytic activity to combust the fuel components in the combustion reaction channel. The combustion reaction releases heat, further heating the reaction mixture, which in turn transfers heat to the reforming mixture through the thin metal, heat conductive separator. This would serve to provide sufficient heat to start the system. The start up heater could be very small since it would only have to heat the gas mixture to a temperature at which the catalyst would have a high activity. In addition, the hot gas would only have to raise the temperature of the thin metal separator which has a very low heat capacity and